PULP & PAPER

April 1992

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This issue's environmental focus includes a report (p. 107) on Pope & Talbot's efforts along with Oregon's environmental protection division to meet regulatory requirements. In the cover photo, Pope & Talbot's environmental manager Roger Sherwood examines cattail roots at the Halsey, Ore., mill's experimental wetlands/ wastewater treatment facility. (Photo courtesy of Pope & Talbot).

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Mexico's paper industry set for growth

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ABP BPA

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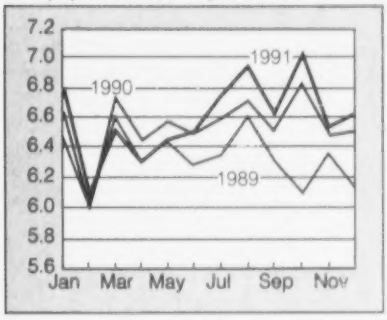
U.S. paper and board production



U.S. production of paper and paperboard totaled 6.6 million tons in December 1991, up 1.5% from the previous year, according to the American Paper Institute. The increase brought total production for the year to a new high of 79.4 million tons, up 0.8% from 1990. Paper production was off 0.7% from 1990 to 39.1 million tons, as increased output in the middle of the year was not enough to offset a shortfall of 1.4% in the first half and a sharp dropoff in November and December. Paperboard continued to strengthen as the year progressed, ending the year up 2.3% to a record 40.3 million tons.

Among major grades, only newsprint posted a gain for the year in the paper sector. Printing and writing shipments dropped 1.2% to 22.1 million tons, despite a 7.7% increase in office reprographics demand. Book and magazine publishers reduced receipts about 11%, while commercial printing held even. Unbleached kraft paperboard production for the export market rose 21.1% in 1991, while containerboard production for the domestic market grew 0.8%.

Canadian newsprint shipments totaled 713,000 metric tpy in December, down 3.6% from a year earlier. Woodpulp shipments climbed 28.9% to 851,000 tons. Newsprint production for the year declined 1.0% to 9.0 million tons, while pulp output rose 2.0% to 23.2 million tons. ■

	Latest month (000 short tons)		% change from year ago	Annualized year-to-date (000 short tons)	% change from year ago
PAPER & PAPERBOARD PRODUCTION [1]					
Newsprint	Dec.	582	1.0	6,841	3.5
Uncoated groundwood (s)	Dec.	140	-4.8	1,775	-1.7
Coated paper (s)	Dec.	566	0.4	7,310	-3.0
Uncoated free-sheet (s)	Dec.	929	-0.1	11,552	0.4
Other printing/writing	Dec.	107	-11.6	1,463	-7.6
Total packaging and other paper (s)	Dec.	357	0.0	4,469	-2.3
Tissue	Dec.	464	-4.1	5,669	-2.3
Total paper	**Dec.**	**3,145**	**-1.1**	**39,078**	**-0.7**
Unbleached kraft paperboard	Dec.	1,860	3.6	20,949	2.9
Semichemical medium	Dec.	506	2.4	5,713	0.1
Bleached paperboard	Dec.	374	1.1	4,556	3.6
Recycled paperboard	Dec.	733	7.8	9,105	1.7
Total paperboard	**Dec.**	**3,474**	**4.0**	**40,323**	**2.3**
Total U.S. paper and paperboard output	**Dec.**	**6,619**	**1.5**	**79,401**	**0.8**
PULP, WASTEPAPER & FIBER [2]					
Total U.S. woodpulp production	Dec.	5,472	0.8	63,818	1.2
Market pulp production	Dec.	823	11.7	9,045	2.8
Wastepaper consumption at paper/board mills	Dec.	1,883	9.7	22,733	8.4
Pulpwood consumption (cords)	Nov.	7,966	-1.9	98,439	-0.9
CONVERTED PRODUCTS STATISTICS [3]					
Corrugated box shipments (billion ft²)	Dec.	23.453	8.7	319.998[6]	0.6
Containerboard inventories at U.S. box plants and mills	Nov. 30	2,487	-1.9		
INTERNATIONAL TRADE [2]					
U.S. paper imports (including products)	Dec.	1,007	-5.9	12,149	-7.3
Imports of Canadian newsprint	Dec.	583	-11.4	7,436[6]	-9.2
U.S. paper exports (including products)	Dec.	663	21.4	8,302	21.5
Exports of unbleached kraft linerboard	Dec.	240	37.9	3,020	16.0
Exports of woodpulp	Dec.	476	-0.2	6,238	5.6
Norscan pulp inventories[4]	Dec. 31	1,232	-9.3		
Norscan pulp operating rates[4]	Dec.	85%	91%	88%	86%
CANADIAN STATISTICS [5] *(reported in metric tons)*					
Total newsprint shipments	Dec.	713	-3.6	8,756[6]	-3.5
Operating rates	Dec.	74%	83%	87%	89%
Inventories held by U.S. consumers	Dec. 31	1,234	-0.6		
Other paper/board shipments	Dec.	551	2.4	7,536	1.0
Woodpulp shipments (export only)	Dec.	851	28.9	8,617	12.1
Operating rates	Dec.	74%	78%	86%	86%

1. American Paper Institute. 2. API, Bureau of Census, American Pulpwood Assn. 3. Fibre Box Assn., Paperboard Packaging Council. 4. North American/Scandinavian paper-grade market pulp. 5. Canadian Pulp & Paper Assn. 6. Not annualized. (s) = Shipments.

Uncoated free-sheet: 1992 may rally, but oversupply persists

Grade structure: Chemical pulps (sulfate, sulfite, soda, cotton linters, or vegetable fiber) are used to make uncoated papers, with occasional additions of up to 10% mechanical fiber, with some mills using bleached chemi-thermomechanical pulps (BCTMP) and recycled fibers. BCTMP furnishes lower the cost of manufacture while providing a better grade of paper than stone groundwood or other mechanical pulps. Many of the major producers have converted some or all of their machines to alkaline-based paper, and most new installations are alkaline.

Uncoated free-sheet papers are used for publishing, commercial printing, office/business, and writing. A smaller subgrouping includes products such as cigarette papers and carbonizing tissue, and there are various converting substrates.

Printing offset and office reprographic papers each represent about one-quarter of uncoated free-sheet production in the U.S.The rise in office reprographics is increasing the share of cut-size bond papers for such uses as computer page (laser) printers and photocopiers. Form bond has been losing ground to cut-size bond, dropping to about 19% of 1991 production of uncoated free-sheet papers. Envelope grades represented just over 10%, tablet was under 4%, text and cover grades were slightly over 3%. Miscellaneous printing/writing papers made up the balance.

Production/capacity: Most U.S. uncoated free-sheet capacity growth in recent years has been in the South, with the exception of a very large machine in the upper Midwest, after developing its base in the Northeast and Midwest. Domtar Inc. and Canadian Pacific Forest products Ltd. have been leaders in increasing Canadian uncoated free-sheet capacity.

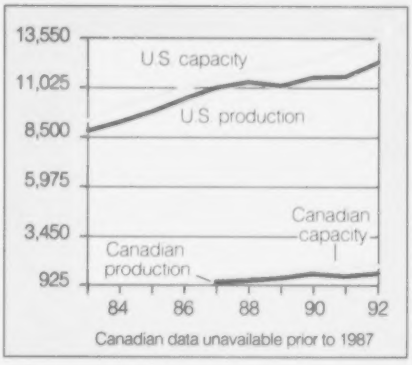
U.S. uncoated free-sheet paper capacity is forecast to advance 3.9% to almost 13.5 million tons in 1992, according to the American Paper Institute. Canadian capacity will grow by 3.9% to 1.7 million short tons, the Canadian Pulp & Paper Assn. projects.

Some tonnage remains to come online from 1991 startups, but only a relatively small machine at Kimberly-Clark Corp.'s Neenah Paper Div. mill in Whiting, Wis., is due online in 1992. Projects over 1993-94 include Champion International Corp., Courtland, Ala., 240,000 tpy; Willamette Industries' Penntech Papers, Johnsonburg, Pa., 210,000 tpy; and Appleton Papers, Combined Locks, Wis., 75,000 to 80,000 tpy. International Paper Co. will probably add a second machine at Selma, Ala., in 1994-95. Boise Cascade Corp., may phase out 22,000 tpy of uncoated free-sheet production at St. Helens, Ore.

Outlook: Operating rates dipped to 89% to 90% for U.S. mills in 1991, down from 93.3% in 1990. Economic rebound and absorption of new capacity will boost utilization to 91% to 92% this year, if the economy is strong, but not until the second half. Inventory rebuilding may begin, spurred in part by price increases announced for February and March. But most customers are wary of carrying excess, overpriced inventories after the difficult 1990-91 period, and an uncertain business climate.

Pricing: Prices suffered drastic discounts in 1991, and three price hikes in quick succession toward the end of 1991 essentially failed. Price trends for two important grades are (year-end, $/short ton): book paper, No. 3 offset, 45-lb sheets: 1987, $850; 1988, $1,020; 1989, $940; 1990, $1,020; 1991, $940. Bond, No. 4, reprographic, 20-lb, 83-bright: 1987, $820; 1988, $960; 1989, $920; 1990, $960; 1991, $680-700. ■

SUPPLY/DEMAND (000 tons)



Canadian data unavailable prior to 1987

FORECAST (000 tons)

U.S.	1990	1991	1992e
Production[1]	11,503	11,552	12,271
Capacity	12,335	12,981	13,482
Utilization rate	93.3%	89.0%	91.0%
Imports	752	679	810
Exports	232	358	372
Apparent U.S. consumption	12,023	11,873	12,709
lb/capita[2]	96.19	93.99	99.87
GDP ratio (1982)	2.89	2.84	2.87
Canada			
Production[3]	1,359	1,242	1,390
Capacity[1]	1,574	1,651	1,716
Utilization rate	86.3%	75.2%	81.0%
Exports[3,4]	662	616	690
Consumption[3]	697	626	700

e=Estimate. 1. API. 2. Revised. 3. CPPA. 4. More than 90% is shipped to U.S.

TOP NORTH AMERICAN PRODUCERS

Company	Annual capacity (000 tons)	Market share (%)
1. International Paper	2,250	14.8%
2. Georgia-Pacific/GNN	2,240	14.7%
3. Champion International	1,226	8.1%
4. Boise Cascade	1,180	7.8%
5. Union Camp	1,100	7.2%
6. Weyerhaeuser[1]	799	5.3%
7. James River	730	4.8%
8. Domtar	650	4.3%
9. Willamette	600	3.9%
10. Mead[1]	550	3.6%

Market share of top five companies:
62.7%

Market share of top ten companies:
77.6%

Total North American capacity/yr. (1992)[4]
15,198

Capacity share of top ten companies:
U.S.: 13,482 million short tons.
Canada (est.): 1,716 million short tons.

1. Year-end 1991 capacity. 2. Includes Prince Albert, Sask. 3. Includes carbonless basestock, Gilbert Paper. 4. Includes all other companies. Sources: Company data, Dean Witter, Morgan Stanley, *Pulp & Paper* estimates.

Domtar shuts newsprint machine as banks pull reigns

Domtar Inc.'s banking syndicate has restricted the Montreal-based forest products company from paying common share dividends or making acquisitions in exchange for supporting the firm through its current financial crisis. The banks have also put caps on the company's total debt, borrowing by subsidiaries, and capital expenditures, according to a prospectus for a planned share offering by the struggling company.

In a flurry of activity on the eve of reporting a loss of C$148 million in 1991, Domtar announced the closure of the one newsprint machine at its Red Rock, Ont., mill and indicated it is re-emphasizing its product focus on its fine papers and packaging businesses. The company also revealed plans to raise C$300 million in cash, to "get us on solid footing," a company spokesperson said, with plans for the establishment of a new bank credit facility, share offerings in Canada and in the U.S., and conversion of a Quebec government loan. As part of their support for Domtar, the banks have also imposed a form of protection measure that would make all loans payable within 60 days in the event of an unwanted takeover.

Domtar reported sales of C$1.8 billion in 1991, down 22.0% from 1990, while its 1991 loss of C$148 million compared with a 1990 loss of C$294 million, including C$198 million in nonrecurring items. The company said it has cut costs by C$135 million, mainly through plant closings and 3,000 layoffs since 1989. As of late February, an additional 500 jobs were slated to be cut this year.

Red Rock closure. Perhaps symbolic of the company's future role in newsprint, Domtar said it will permanently shut down the only newsprint machine at its Red Rock mill in May and reorganize the facility's linerboard operation. The closure will eliminate 87,000 metric tpy of newsprint capacity and affect about 300 hourly and salaried employees, the company said.

The closure of No. 1 machine will eliminate about 32% of Domtar's total newsprint capacity, with remaining production of standard newsprint and groundwood specialties at Dolbeau and Donnacona, Que. The future of those mills is also in question, with analysts saying the uncompetitive facilities should be closed or sold. But with the show of financial support by the Quebec government agencies in Domtar's future, the possibility of permanently shutting down mills in the province becomes a controversial issue. The Quebec government holds a 42% share in the company.

The company had been demanding that Red Rock workers accept a 20% cut in wages and benefits, as well as a 20% cut in the work force, to keep the mill open. The Canadian Paperworkers Union (CPU) rejected the proposals, saying it was skeptical about the company's commitment to keep the mill open. "I think I knew deep in my heart there wasn't much hope for the newsprint machine," a union leader said.

The company revealed plans to improve its other paperboard businesses at Trenton and Mississauga, Ont. Analysts indicated that although the company would probably be willing to sell its packaging operation, Domtar enjoys a strong containerboard business in eastern Canada and may seek to expand its role in the northeastern U.S. Domtar management continues to identify the company's fine paper operation as a long-term core business. But as a further obstacle, the company said it faces a C$420-million price tag to bring its mills into environmental compliance by 1996, if all existing mills remain in operation.

Separately, Hydro-Quebec gave its approval for Domtar to install a cogenerating unit at the company's Windsor, Que., fine papers mill for the production of steam and electricity. The project will cost an estimated C$170 to C$200 million, creating 30 permanent jobs when finished. Domtar said it expects the project to cut energy costs at Windsor by 20% and increase production 27%. ■

SALES AND EARNINGS

Canadians again post massive losses

The closing months of 1991 were not good times for producers of newsprint, market pulp, or wood products—the Canadian forest product industry's three most important sources of revenue. A *Pulp & Paper Week* survey of 17 companies showed a net loss, excluding nonrecurring items, of C$401.8 million on sales of C$4.1 billion for the quarter ending Dec. 31, 1991. In comparison, this same group posted a C$188-million net loss on sales of C$4.5 billion in the year-ago period and a C$323-million net loss on sales of C$4.3 billion for the three months ended Sept. 30, 1991. These totals understate the extent of the industry's woes, since any losses associated with the shutdown of facilities, which would have otherwise been losing money, have been treated as nonrecurring. Inclusive of net nonrecurring items, the 17 companies surveyed suffered an aggregate loss of C$846 million for the three months ended Dec. 31, 1991, compared with deficits of C$408 million in the year-ago period and C$261 million for the three months ended Sept. 30, 1991.

For the full year, this group reported a staggering C$1.5-billion net deficit, including about C$435 million in net nonrecurring items, giving credence to the assertion that conditions in the Canadian forest products industry were as bad in 1991 as at any other time in the last fifty years.

Looking to the future, the picture is mixed. Although most industry players will probably post losses in 1992, there are signs that better times may be on their way for some. Most immediately, the lower interest rates should not only soften the burden of high debt within the industry but also are expected to pave the road for improved results in the wood products sector. And market pulp producers are cautiously optimistic that prices bottomed in late 1991—the speed and extent of this market's recovery, however, is in question.

Another boost to corporate bottom lines in 1992 should be provided by widespread cost cutting and restructuring efforts undergone in the last two years. In addition, the recent decline in the Canadian dollar (relative to its U.S. counterpart) should help. (A one-cent move in the exchange

rate boosts the pretax earnings of this group by an estimated C$100 to C$150 million.) But there is still plenty of room for concern. Newsprint producers face a particularly daunting 1992, during which costs are going to be incurred either in the shutting down of marginal capacity or else through chronically depressed pricing. Finally, the possibility of labor disruptions this spring, in British Columbia and/or eastern Canada, is a key wild card.

Newsprint producers reeling. Canadian Pacific Forest Products Ltd. had the unwanted distinction of posting the largest 1991 deficit (C$572 million) in the industry as each one of CP Forest's businesses reported a deficit for the year. The heaviest operating loss (C$185.3 million excluding nonrecurring items) was generated at the newsprint segment, but the most severe decline in profitability was at the company's pulp operations, where a C$119-million operating profit in 1990 turned into a C$90-million deficit in 1991. The C$572-million figure also includes charges related to anticipated closure and downsizing costs and a write-down of its paperboard and packaging businesses offset by gains related to its divested Facelle tissue subsidiary.

Abitibi-Price Inc.'s reported net loss totaled C$75.9 million, including about C$27.5 million in nonrecurring costs related to the restructuring and downsizing of certain facilities, which included closure of a newsprint mill at Thunder Bay, Ont., and a paper coating operation in Georgetown, Ont. On a more positive note, Abitibi-Price, one of the first companies to recognize that newsprint markets were going to struggle in the early 1990s, has managed, through asset sales and cost cutting efforts, to maintain a strong financial base.

From Riches to Rags. In 1990, the two most profitable forest products companies in Canada were British Columbia-based Fletcher Challenge Canada Ltd. and MacMillan Bloedel Ltd., but the tables turned in 1991. Despite a C$47.5 million contribution from its Dutch fine papermaking subsidiary, KNP, MacMillan Bloedel reported a C$93-million net loss. Looking forward, MB's president and CEO, Bob Findlay, cautioned that the company "still faces complex problems in the next few years, the most serious of which is that the Canadian industry is no longer cost-competitive with the U.S. We must face the fact and deal with it quickly."

The story at Fletcher Challenge Canada was very similar. Reduced demand and weak prices made 1991 one of the most difficult years in the company's history and, although FCC's president and CEO, Ian Donald, said the company expects 1992 to produce some modest improvements in its market areas, he cautioned that the rate of recovery is likely to be slow. The only Canadian companies reporting profits from continuing operations were Scott Paper Ltd. and Cascades Inc., while greater optimism in the wood products business and the apparent bottoming of pulp markets are brightening prospects at a number of western Canadian firms. ■

Canadian paper and forest products company sales and earnings.

Company	Full year 1991 (C$000) Sales 1991	% change 1991/90	Earnings[1] 1991	Earnings[1] 1990
Abitibi-Price Inc.	C$2,800,500	−9.3%	C$ (48,370)	C$ (16,860)
Canadian Pacific Forest Products Ltd.[2]	1,979,500	−5.7	(261,500)	(16,800)
Canfor Corp.	822,500	−7.0	(96,400)	(22,400)
Cascades Inc.	806,205	−1.5	19,657	26,837
Crestbrook Forest Industries Ltd.	165,400	−24.9	(16,414)	11,000
Domtar Inc.[3]	1,804,000	−22.0	(148,000)	(96,000)
Donohue Inc.[3]	469,900	−23.1	(5,900)	29,100
Fletcher Challenge Canada Ltd.	1,037,600	−10.6	(61,600)	33,900
MacMillan Bloedel Ltd.	2,726,200	−9.2	(73,400)	50,800
Noranda Forest Inc.	4,118,000	−9.6	(185,000)	(95,000)
Repap Enterprises Corp. Inc.	1,065,300	−13.2	(150,700)	3,100
Rolland Inc.	302,928	−24.7	(7,726)	(3,464)
Scott Paper Ltd.	434,791	−9.0	12,321	13,847
Slocan Forest	192,400	−3.4	(14,200)	(1,300)
Tembec Inc.[3]	256,718	7.9	(27,095)	18,374
Weldwood of Canada Ltd.	661,700	−3.2	(33,100)	5,400
West Fraser Timber	533,900	−1.2	(16,500)	3,400
Total[4]	**C$17,451,342**	**-10.8%**	**C$(1,085,127)**	**C$(81,466)**

1. Income after taxes from continuing operations, excluding most significant nonrecurring items in both years. ( ) = losses. **2. CP Forest.** 1991 earnings exclude charges of $368.1 million, all booked in the fourth quarter, related to the shutdown, downsizing, and write-down of certain operations. 1991 earnings exclude $58.1-million gain from this continued operations, of which $400,000 was booked in the fourth quarter. 1990 earnings exclude $7.4-million gain from the discontinued operations, of which $2.5 million was booked in the fourth quarter. **Domtar.** 1990 earnings exclude unusual charges of $237 million, all booked in the fourth quarter, and $39 million in profits from discontinued operations, of which $10 million was booked in the fourth quarter. **Donohue.** 1991 earnings exclude nonrecurring losses of $52.1 million, of which $32.7 million was booked in the fourth quarter. **Tembec.** Latest quarter (ended Dec. 31) is the first quarter of Tembec's 1992 fiscal year. Full-year results are for 12 months ended Sept. 30. 1991 earnings exclude $27 million unusual loss. **Totals.** Noranda Forest accounts for MacMillan Bloedel, in which it has a roughly 50% stake, as a consolidated subsidiary. Accordingly, to avoid double counting, MB's sales and half of its earnings are excluded from the totals line.

CONTAINERBOARD

Weyco to spend $70 million at Springfield

Weyerhaeuser Paper Co. said it will proceed with a $70-million recycling and machine modernization project for its Springfield, Ore., kraft linerboard mill. Construction is scheduled to begin later this year and will be completed by the end of 1993, lifting capacity at the 1,570-tpd mill by approximately 15%, or 225 tons, said Richard Hanson, vice president and mill manager.

The Springfield project was originally announced in 1990, but was later put on hold because of poor business conditions in the containerboard market. About $45 million of the capital

Proper Design, Control Strategies Can Help Mills Cut TRS Emissions

Amendments to the Clean Air Act push the pulp and paper industry to reduce total atmospheric sulfur emissions

By JERRY W. GARNER

The Clean Air Act was promulgated in 1970 and substantially amended in 1977 and 1990. Preservation of ambient air quality is the goal of the statute. In the pulp and paper industry, atmospheric emissions of sulfur gases and particulate matter are the principal issues.

Total atmospheric sulfur emissions from the pulp and paper industry are small in comparison with emissions from the electric utility industry and other major industrial sources. Figure 1 illustrates a relative comparison of sulfur emissions from the pulp and paper industry and other major industrial processes.

This comparison of atmospheric sulfur emissions is based on an Environmental Protection Agency (EPA) sulfur dioxide (SO_2) inventory taken in 1985 and a Jaakko Poyry estimation of total reduced sulfur (TRS) emissions from the pulp and paper industry, expressed as equivalent sulfur dioxide.

WHERE TRS COMES FROM. Major gaseous emissions from kraft pulping and papermaking processes are reduced sulfur compounds, principally hydrogen sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide. These compounds are extremely odorous and can be detected at threshold levels of 1 to 10 ppb (parts per billion) by volume. Consequently, the pulp and paper industry has committed significant human resources and capital expenditures to control TRS emissions. Capital expenditures for air emission control projects scheduled to start up in 1990 were estimated to exceed $600 million.

Typical TRS generation in the kraft pulping process is illustrated in Figure 2. Major sources of TRS generation in the kraft process include digester blow and relief gases, pulp washer hood and seal vents, multiple-effect evaporator hotwell vents, chemical recovery boiler flue-

Mr. Garner is manager–power and recovery projects, Jaakko Poyry Inc., Raleigh, N.C.

FIGURE 1: **Sulfur emissions from select industries (1,000 tons/year).**

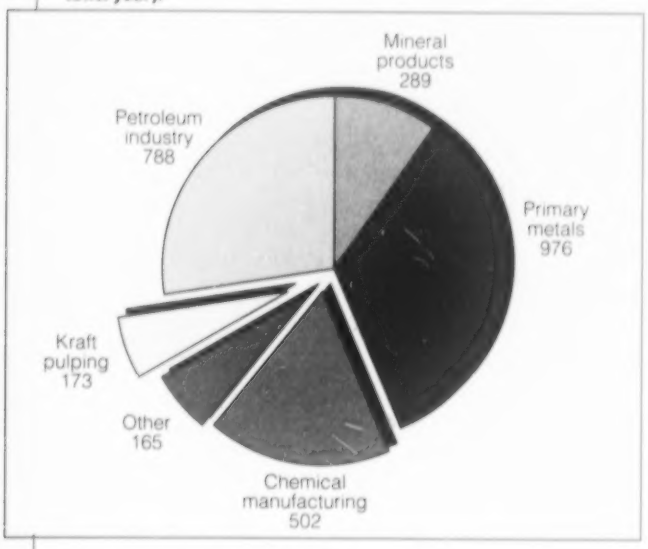
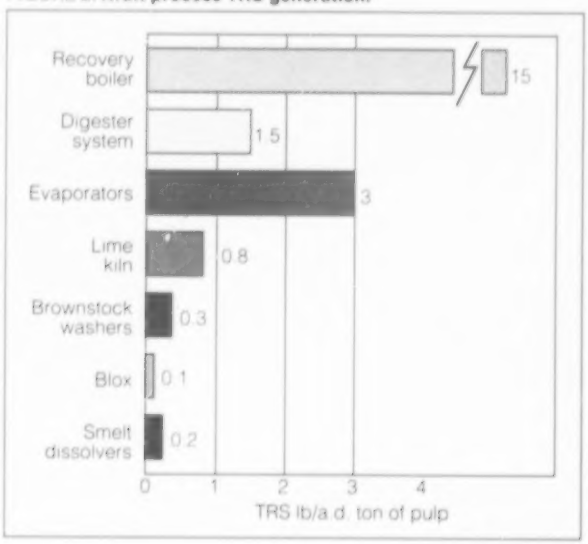


FIGURE 2: **Kraft process TRS generation.**



gas, smelt dissolving vents, black liquor oxidation tanks, and lime kiln fluegases. Technological advances in the pulping process since promulgation of the Clean Air Act have allowed significant reductions in atmospheric discharges of TRS.

Advanced process and emission control technology can result in kraft mill TRS emissions to the atmosphere of approximating 1 lb/a.d. ton of pulp production, as illustrated in Figure 3.

TRS generation in the recovery boiler originates in the furnace from combustion of organic and inorganic sulfur compounds used in the pulping process and from the direct-contact black liquor evaporator, if included in the boiler design. Recovery boiler TRS emission control technology includes modification of direct-contact evaporator design and sundry boiler process control techniques. Process control advancements may include refined combustion air controls, control of black liquor fuel moisture content and spray pattern, and smelt bed control.

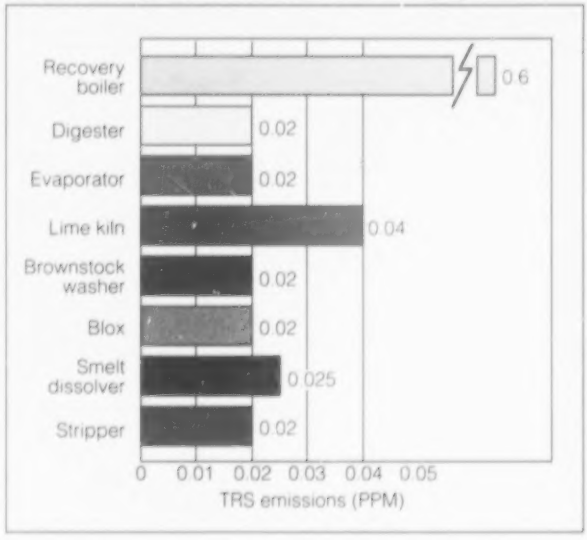
The principal source of digester-area TRS generation is noncondensible gases liberated during the digestion of woodchips at elevated temperature and pH in an inorganic sulfur solution. Common control technology for digester-area TRS emissions is to collect and treat the malodorous noncondensible gases by alkaline scrubbing or combustion. Noncondensible gases are combusted in an existing mill boiler or lime kiln. Alternatively, a dedicated incinerator with fluegas scrubbing may be installed for TRS gas disposal. Pulp washer hood vents may also be included in the TRS gas collection and disposal system design.

Atmospheric emissions of TRS from the multiple-effect evaporators originate as noncondensible gases liberated from the spent pulping liquor. These malodorous sulfur gases are liberated during evaporation of water from the pulping liquor at elevated temperatures. Effective TRS emission control strategy is to collect the noncondensible gases for treatment by scrubbing or combustion.

Sources of lime kiln TRS emissions are sulfur-bearing streams entering the kiln, including lime mud, mud washwater, fossil fuel, and noncondensible gases. Typical control technology includes efficient washing of lime mud using freshwater and conservative mud filter design, alkaline scrubbing of noncondensible gases prior to combustion, and use of low-sulfur-content fossil fuel. Advanced combustion controls for the lime kiln allow control of the excess air, residual fluegas oxygen, and cold end temperature for reduced TRS emission from the kiln. If fluegas scrubbing is included in the kiln system design, operation with an alkaline scrubber water solution provides minimum atmospheric TRS emission.

Black liquor oxidation (BLOX) systems are used in conjunction with chemical recovery boilers having direct-contact evaporator design. Direct-contact evaporators use the sensible heat of the boiler fluegas in direct contact with the black liquor fuel to evaporate moisture from the fuel. Malodorous TRS gases are stripped from the black liquor fuel by the fluegas and are discharged into the atmosphere.

FIGURE 3: **Controlled TRS emissions from kraft pulp mill.**



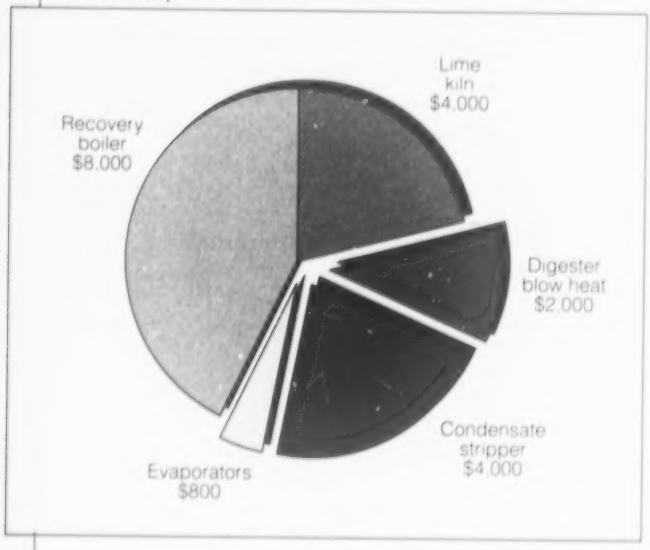
A BLOX system is designed to oxidize the reduced sulfur compounds in the black liquor prior to contact with the boiler fluegas, thereby reducing TRS emission to the atmosphere. However, large volumes of compressed air are used in the BLOX system, and the off-gas contains residual concentrations of TRS compounds. Common TRS emission control strategy is to combust the large volume of BLOX off-gas as combustion air in an existing boiler.

A principal product from the chemical recovery boiler is a smelt stream of inorganic reduced sulfur chemicals that are recycled in the kraft pulping process. The molten smelt stream is dissolved in an aqueous solution, and vent gases are liberated. The vent gases contain residual concentrations of TRS compounds. Common control technology for atmospheric TRS emission from the smelt dissolver is either alkaline scrubbing or combustion of the vent gases. Effective process control would dictate the use of sulfur-free freshwater as vent gas scrubbing medium.

Foul (malodorous) condensates are generated due to vapor condensation in the digester and evaporator process areas. These process condensates contain relatively high concentrations of TRS compounds, which tend to volatilize at atmospheric conditions. Condensate stripping is commonly used to volatilize TRS compounds; the stripped condensates can then be recycled in the kraft pulping process. However, the stripper will produce overhead gases with high concentrations of TRS compounds. The overhead gases are typically incinerated for TRS emission control.

COSTS FOR COMPLIANCE. Capital cost estimates for recent TRS compliance projects in several kraft pulp mills are presented in Figure 4. Capital costs for recov-

FIGURE 4: **Expenditures for TRS-control retrofit (costs is thousands).**



ery boiler compliance approximate $8 million and include necessary provisions for the replacement of the direct-contact evaporator with extended economizer design and additional black liquor evaporator capacity for liquor fuel drying. Evaporator process capital costs approximate $800,000 and include foul condensate segregation in the appropriate evaporator effects and condensate handling.

Digester-area capital costs for TRS compliance are estimated at $2 million and include provisions for efficient blow heat vapor recovery, foul condensate collection and handling, and miscellaneous collection of concentrated TRS gas streams. Capital estimation of almost $4 million includes a foul condensate stripper system to volatilize TRS compounds generated in the digester and evaporator areas and to produce clean condensate for recycle.

Estimation of capital costs of $4 million for lime kiln TRS emission compliance includes additional lime mud filter capacity, a noncondensible gas transportation system, and a noncondensible gas combustion system.

Total capital expenditures for TRS compliance average about $50/ton of annualized pulp production capacity. In summary, TRS emission compliance can be readily achieved in existing or greenfield kraft pulp mills utilizing proven technology. Capital expenditures can be minimized by judicious design, deliberate integration of new and existing equipment, and aggressive competitive bidding of new equipment. ■

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